

FILTERING SYSTEM FOR RUNOFF WATER

I claim the benefit of prior copending provisional application S.N. 60/271,065, filed February 26, 2001, entitled Filter, of Thomas E. Pank.

Background of the Invention

Parking lots, the roads of filling stations and other places have oil and/or an emulsion of oil and water in the runoff water. These oils have been removed from the runoff water by a two stage process. Such a process includes first gravity separation which removes all oil other than the emulsion of oil and water from the runoff water, and secondly a filter for removing emulsion.

The present invention is an improved filtering system for use as the second of the above two stages.

Cylindrical filters, having two or more concentric layers, through which the liquid to be filtered pass in a radial direction are old, see U.S. Patents 2,742,160 to Fogwell, 3,442,391 to Bozek, and 5,811,002 to Felber. Moreover, patents disclosing filters for drainage water include U.S. Patent 6,027,639 to Lenhart, Jr. and 6,190,545 to Williamson.

Summary of the Invention

The runoff water which is processed by the present invention may vary from a very low rate of flow to a very high rate of flow. That portion of the runoff water that is within the capacity of this filtering mechanism is fed to a reservoir and from the reservoir to plural cylindrical filter cells where the runoff water is filtered and fed to an outlet.

However, when the rate of flow of the runoff water exceeds the capacity of the filtering system it may follow a direct path from the inlet to an outlet. To carry the foregoing, a tank receives the inlet water and feeds it to a reservoir which in turn feeds the water to the cylindrical filter cells. The water passing through the filter cells is received by a manifold which feeds the clean water to an outlet. However, when the runoff water has a high rate of flow the reservoir soon overflows and the excess water flows directly to an outlet.

The reservoir may be either above or below the filter cells. If above, the water entering the inlet flows downward to a reservoir which is perforated to provide water to the filter cells. If, however, the reservoir is below the filter cells, it has a perforated top which feeds the filter cells. The water in the reservoir is under pressure. The pressure is sufficient to force the water through the filter cells to the outlet. The pressure may be obtained by confining the water in a column that extends alongside the filter cells.

The filter cells may be cylindrical. They have an inner vertical cylindrical passageway surrounded by one or more cylindrical layers. One filtering media is in said inner passageway. Each cylindrical layer provides a different filtering media. In one form of the invention the filtering media in the inner passageway is a coarse media and the filtering media in the other cylindrical layers or layers is a finer media.

Each layer of the filter is bounded by a porous barrier. Surrounding, and spaced from, the outermost barrier is an outer wall. The space between the outermost barrier and the wall forms a drain for feeding the filtered liquid to an output.

Brief Description of the Drawings

Figure 1 is a plan view of the preferred form of the invention.

Figure 2 is a sectional view of the preferred form of the invention taken along line 2 - 2 of Figure 1.

Figure 3 is a plan view of the filter mechanism 105 for the preferred form of the invention.

Figure 4 is a sectional view of the filter mechanism 105 taken along line 4 - 4 of Figure 3.

Figure 5 is a sectional view of the filter mechanism 105 taken along line 5 - 5 of Figure 3.

Figure 6 is a sectional view of the filter mechanism 105 taken along line 6 - 6 of Figure 3.

Figure 7 is a plan view of the filter mechanism 105 for a First Modified Form of the Invention.

Figure 8 is a sectional view of the filter mechanism 5 of the First Modified Form of the Invention taken along line 8 - 8 of Figure 7.

Figure 9 is a plan view of a Second Modified Form of the Invention.

Figure 10 is a sectional view of a Second Modified Form of the Invention taken along line 10 - 10 of Figure 9.

Figure 11 is a sectional view of a Third Modified Form of the Invention.

Figure 12 is a sectional view of the filter mechanism 201 in the Third Modified Form of the Invention.

Figure 13 is a detailed sectional view of a part of filter cell 211 in the Third Modified Form of the Invention.

Figure 14 is a detailed sectional view of filter cell 211A in the Third Modified Form of the Invention.

Figure 15 is a detailed section view of a filter insert 201 which consists of only one filter cell.

Detailed Description of the Preferred Form of the Invention

Parking lots and other paved areas build up contaminants such as oils during everyday use. During a storm, these oils are carried into the storm drain by the stormwater runoff, which is usually discharged to a river or stream. The present invention is a system for removing oils from stormwater runoff by using filtration.

The conventional prior art relies on gravity separation to remove oils from stormwater runoff. Free oils can be removed by this method, but emulsified and dissolved oils cannot. The present invention makes use of a fine filter media to trap those oils that cannot be removed in a conventional gravity separator. Used in conjunction with a gravity separator such as those described in U.S. Patents 5,746,911 and 8,264,835, both to Pank, the present invention comprises a two stage process for the removal of oils from runoff water.

Figures 1 to 6 illustrate the preferred form of the invention.

In Figures 1 and 2, there is a tank 100 that has an inlet conduit such as pipe 101, a clean water outlet conduit such as pipe 102, and an overflow outlet conduit such as pipe 103. The clean water outlet pipe 102 is at a substantially lower elevation than the inlet pipe 101, and the overflow outlet pipe 103 is at the same elevation as the inlet pipe 101. There is a spillway 101A at the end of inlet pipe 101 that extends to the edge of the filter mechanism 105. The clean water outlet conduit 102 and overflow outlet conduit 103 may be kept separate to maintain segregated waste streams, or may be combined into a single outlet conduit.

The filter mechanism 105 is shown in Figures 3 and 4. The filter mechanism is divided into concentric filter cells 110 and 110A by inner walls 111, and surrounded by outer wall 112. Outer wall 112 is taller than inner walls 111. A reservoir 113, with one side, in this case the bottom side, perforated. The reservoir is formed by outer wall 112 and the tops of the filter cells 110 and 110A.

Each interior filter cell 110 is constructed as shown in Figure 5. The inner walls 111 constitute the vertical boundaries of the cell, and perforated plate 125 constitutes the floor. The entire filter mechanism 105 is held above the floor of tank 100 in any suitable way. A drain 124 is fastened along the inside of the inner walls 111. The drain is

bounded by barrier 123, which separates the drain 124 from a fine filter media 122.

Barrier 123 is a geotextile or similar device that is fine enough to retain fine filter media 122, but porous enough to allow water to pass through it. A second barrier 121 separates the fine filter media 122 from a coarse material 120. Like barrier 123, barrier 121 is also a geotextile or similar device that is fine enough to retain fine filter media 122, but porous enough to allow water to pass through it. Barrier 121 extends along the top of the fine filter media 122 to the inner wall 111.

The tank 100 is a large chamber. Inside of the large chamber is a smaller chamber 112 containing the filter cells 110 and 110A. Each filter cell, such as those shown in Figures 5 and 6, has a first passageway along the vertical center line of the cell and containing the first filter media 120. A second passageway, is in the form of drain 124. The fine filtering media comprises the second filtration media.

The exterior filter cell 110A is shown in Figure 6. An inner wall 111 forms one vertical boundary, while the outer wall 112 forms the other vertical boundary. Perforated plate 125, drain 124, barrier 123, fine filter media 122, barrier 121, and coarse material 120 are arranged as they are in the aforementioned interior filter cell 110.

Operation of the Preferred Form

When the runoff entering inlet pipe 101 has a low rate of flow, the water is passed from spillway 101A into reservoir 113 above filter mechanism 105. Because the oil entering the system is emulsified or dissolved, the oil does not remain on top of the water in reservoir 113, but is instead mixed throughout the water. From reservoir 113, the water flows into coarse material 120. Coarse material 120 has a large volume of voids and provides little resistance to the flow of water, thus the water is distributed evenly throughout coarse material 120.

As coarse material 120 becomes saturated, the runoff water will penetrate barrier 121 and enter fine filter media 122. Fine filter media 122 provides significantly more resistance to flow than does coarse material 120. Furthermore, the finer particles create a more tortuous flow path, allowing for longer contact time between the runoff water and the fine filter media 122, and therefore more efficient pollutant removal. As the fine

filter media 122 slowly becomes saturated, the filtered runoff water will then penetrate barrier 123 and enter drain 124.

Drain 124 is simply an open space that allows the water to flow down along interior wall 111 or outer wall 112 to perforated plate 125. The water flows through the perforations in plate 125 and back into tank 100. From tank 100, the water flows between spacers 106 and enters the clean water outlet pipe 102. The clean water outlet pipe 102 delivers the filtered runoff water to a sewer or stream.

When runoff water enters the inlet pipe 101 at a high rate of flow, the fine filter media 122 restricts the flow through filter cells 110 and 110A, and therefore restricts the flow through filter mechanism 105. In this case, the overflow outlet pipe 103 accepts the excess water from the surface of the reservoir 113 through overflow inlet 103A. Overflow pipe 103 delivers the unfiltered water to a sewer or stream. This can be the same sewer or stream that clean water outlet pipe 102 discharges to, or it can be a different discharge point.

Detailed Description of a First Modified Form of the Invention

As an alternative to the use of multiple concentric filter cells, the present invention can be used with a single filter cell. In this arrangement, the tank 100, inlet pipe 101 with spillway 101A, clean water outlet pipe 102, and overflow outlet pipe 103 with inlet 103A are unchanged, and are arranged as shown in Figures 1 and 2 for the preferred form of the invention. The filter mechanism 105 is positioned in the same place within the invention, but the interior components are altered to create a single filter cell.

Figures 7 and 8 illustrate this First Modified Form of the present invention. The filter mechanism 105 is bounded by outer wall 131, which also creates reservoir 113. The outer wall 139 contains the single filter cell as shown in Figure 8, and perforated plate 135 constitutes the floor. The entire filter mechanism 105 is again raised above the floor of tank 100 in any suitable way. A drain 134 is fastened along the inside of the outer wall 139. The drain is bounded by barrier 133, which separates the drain 134 from a fine filter media 132. Barrier 133 is a geotextile or similar device that is fine enough to retain fine filter media 132, but porous enough to allow water to pass through it. A

second barrier 131 separates the fine filter media 132 from a coarse material 130. Like barrier 133, barrier 131 is also a geotextile or similar device that is fine enough to retain fine filter media 132, but porous enough to allow water to pass through it. Barrier 131 extends along the top of the fine filter media 132 to the outer wall 139.

Operation of the First Modified Form

When the runoff entering inlet pipe 101 has a low rate of flow, the water is passed from spillway 101A into reservoir 113 above filter mechanism 105. Because the oil entering the system is emulsified or dissolved, the oil does not remain on top of the water in reservoir 113A, but is instead mixed throughout the water. From reservoir 113A, the water flows into coarse material 130. Coarse material 130 has a large volume of voids and provides little resistance to the flow of water, thus the water is distributed evenly throughout coarse material 130.

As coarse material 130 becomes saturated, the runoff water will penetrate barrier 131 and enter fine filter media 132. Fine filter media 132 provides significantly more resistance to flow than does coarse material 130. Furthermore, the finer particles create a more tortuous flow path, allowing for longer contact time between the runoff water and the fine filter media 132, and therefore more efficient pollutant removal. As the fine filter media 132 slowly becomes saturated, the filtered runoff water will then penetrate barrier 133 and enter drain 134.

Drain 134 is simply an open space that allows the water to flow down along outer wall 139 to perforated plate 135. The water flows through the perforations in plate 135 and back into tank 100. From tank 100, the water flows between spacers 106A and enters the clean water outlet pipe 102. The clean water outlet pipe 102 delivers the filtered runoff water to a sewer or stream.

When runoff water enters the inlet pipe 101 at a high rate of flow, the fine filter media 132 restricts the flow through the single filter cell, and therefore restricts the flow through filter mechanism 105. In this case, the overflow outlet pipe 103 accepts the excess water from the surface of the reservoir 113 through overflow outlet 103A. Overflow pipe 103 delivers the unfiltered water to a sewer or stream. This can be the

same sewer or stream that clean water outlet pipe 102 discharges to, or it can be a different discharge point.

Detailed Description of a Second Modified Form of the Invention

The present invention can be configured with a single outlet pipe that conveys the filtered water during low flow rate conditions and the unfiltered water during high flow rate conditions to the same discharge point. Figures 9 and 10 show the arrangement of the tank and associated pipes for this form of the Invention.

In Figures 9 and 10, there is a tank 100 that has an inlet pipe 101 and an outlet pipe 141. The outlet pipe 140 is at a substantially lower elevation than the inlet pipe 101. There is a spillway 101A at the end of inlet pipe 101 that extends to the edge of the filter mechanism 105.

In this Second Modified Form of the Invention, the filter mechanism 105 remains unchanged from the Preferred Form of the Invention.

Operation of the Second Modified Form

When the runoff entering inlet pipe 101 has a low rate of flow, the water is passed from spillway 101A into reservoir 113 above filter mechanism 105. Because the oil entering the system is emulsified or dissolved, the oil does not remain on top of the water in reservoir 113, but is instead mixed throughout the water. From reservoir 113, the water flows into coarse material 120. Coarse material 120 has a large volume of voids and provides little resistance to the flow of water, thus the water is distributed evenly throughout coarse material 120.

As coarse material 120 becomes saturated, the runoff water will penetrate barrier 121 and enter fine filter media 122. Fine filter media 122 provides significantly more resistance to flow than does coarse material 120. Furthermore, the finer particles create a more tortuous flow path, allowing for longer contact time between the runoff water and the fine filter media 122, and therefore more efficient pollutant removal. As the fine filter media 122 slowly becomes saturated, the filtered runoff water will then penetrate barrier 123 and enter drain 124.

Drain 124 is simply an open space that allows the water to flow down along interior wall 111 or outer wall 112 to perforated plate 125. The water flows through the perforations in plate 125 and back into tank 100. From tank 100, the water enters the clean water outlet pipe 102. The clean water outlet pipe 102 delivers the filtered runoff water to a sewer or stream.

When runoff water enters the inlet pipe 101 at a high rate of flow, the fine filter media 122 restricts the flow through filter cells 110 and 110A, and therefore restricts the flow through filter mechanism 105. In this case, the excess water flows over the outer wall 112 of filter mechanism 105, and down to the floor of tank 100. From tank 100, the untreated water enters the single outlet pipe 141. The outlet pipe 141 delivers the filtered runoff water to a sewer or stream.

Detailed Description of a Third Modified Form of the Invention

The present invention can be inverted, forcing the water to flow upwards through the filter insert. Figures 11 - 14 show the configuration of the invention for this form.

In figure 11, tank 200 has a sump below the outlet pipe 203, and filter insert 201 is set in that sump. Inlet pipe 202 allows water to flow into tank 200 and into the sump. When the water level in tank 200 exceeds the elevation of clean water outlet pipe 203, water will begin to flow through filter insert 201 and into outlet pipe 203. During a flow rate which exceeds the filter capacity of filter insert 201, water will be allowed to exit tank 200 through overflow pipe 204.

Figure 12 shows a section of filter insert 201 and its connection to clean water outlet pipe 203. Filter insert 201 is bounded by outer walls 210, which connect to clean water outlet pipe 203. Concentric rings 211 are defined within filter insert 201 by inner walls 212, with the outer ring 211A bound by the inner wall 212 on one side and outer wall 210 on the other. Water enters filter insert 201 through a permeable bottom 213, and flows upward through filter top 214. Once clean water flows through filter top 214, it then flows by gravity through clean water outlet 203.

Figure 13 shows a detailed section of one of the concentric rings 211 that make up filter insert 201. The ring 211 is bounded on each side by inner wall 212. Water enters

the filter cell through permeable bottom 213 and flows into the coarse filter media 220. Because of the high permeability of media 220, the water distributes itself evenly through coarse media 220 and flows from there, through permeable barrier 221, and into fine media 222. The water flows mainly horizontally through fine media 222, but near the top of the cell, water may also flow vertically through fine media 222. Once through the fine media 222, water passes through permeable barrier 223 and into vertical drain 224. Once in drain 224, the water flows upward alongside wall 212 until it reaches the top of the filter cell. At the top of the cell, water can flow over wall 212 onto the top of the adjacent cell, until it reaches the outermost filter cell.

Figure 14 shows the outermost filter cell 211A. The filter cell 211A functions the same way as the other cells 211, with the exception that it is bordered by one inner wall 212 and the outer wall 210 of filter insert 201. Water again enters the cell through permeable barrier 213, flows into coarse media 220, flows through permeable barrier 221 into fine media 222, through permeable barrier 223 into vertical drain 224, and upward to the top of the cell. From the top of filter cell 211A, the filtered water leaves the system through clean water outlet pipe 203. In addition to the water that entered filter cell 211A through permeable barrier 213, water also enters cell 211A from adjacent filter cells 211 by flowing over inner walls 212. This water also leaves filter cell 211A through an outlet conduit such as clean water outlet pipe 203.

Figure 15 shows a cross section of filter insert 201 in a final modified form of the invention, in which filter insert 201 consists solely of one filter cell. The filter cell is bounded on each side by outer walls 212, and is in direct communication with clean water outlet pipe 203. Water enters the filter cell through permeable barrier 213, flows into coarse media 220, enters fine media 222 through permeable barrier 221, enters vertical drain 224 through permeable barrier 223, and flows upward until it leaves the filter cell through clean water outlet pipe 203.